

On the Reproduction of Wasps. By M. PAUL MARCHAL*.

The results of my researches on the earth-burrowing wasps (*Vespa germanica*, *V. vulgaris*) are as follows:—

Their nests, when they are fully formed, contain two sorts of cells, the *small* and the *large*. The latter always constitute the lower part of the wasp's nest, for example the two lowest combs, while the others make up the rest of the nest, namely the six to ten combs superposed.

The *large cells*, which are only built by the workers during the first fortnight of August, may, at an early period, receive indifferently either females or males, the former being either queens or very large workers, the latter always in small proportion; afterwards, at the beginning of September, these cells are entirely set apart for the queens to such an extent that in October only queens are to be found in them, the males being entirely excluded.

The *small cells*, on the contrary, from the time that the laying of males has begun, contain indifferently up to the end of the season either workers or males.

The proportion of males in the combs of small cells decreases from below upwards, with this remarkable exception—that if there be a mixed comb containing at one and the same time large and small cells, the small cells of the mixed comb are influenced by the proximity of the large cells, and contain but a very small quantity of males.

The commencement of the period for laying males coincides very nearly with the period of the appearance of the large cells and takes place in the first fortnight of August. The curve which represents their production rises suddenly in an almost vertical manner to reach its maximum; it then descends gradually, with or without oscillations, to the end of the reproduction.

The queen takes a prominent part in this great production of males, because the laying workers have already long since disappeared, whilst the young male larvæ are still to be found in great numbers in the nests.

The queen has then (at least after the early days of September) the power to determine with certainty the female sex of the eggs which she lays in the large cells; on the other hand, she lays indifferently either female or male eggs in the small cells.

One can only admit, in order to explain this remarkable fact, the principle of the theory of Dzierzon, based upon the fecundation, because if the production of males were due, for example, to some influence of season, it is evident that the eggs laid at the *same epoch* in the large cells would become male just as much as the others.

In order to interpret all the facts, this theory ought nevertheless, in my opinion, to be modified, by allowing the intervention of another factor than the will of the queen. We will admit, then,

* This work was carried out partly at the Entomological Station at Paris. The experiments and observations on which the conclusions arrived at are based will be published in detail later.

that after her first deposit (of eggs), exclusively those of workers, which lasts uninterruptedly up to the end of July or the beginning of August, the reflex which brings about the contraction of the seminal receptacle at the moment of the laying of each egg is no longer produced with the same energy, and that therefore the eggs can be laid without being fecundated; thence the almost sudden appearance of males corresponding to the relative state of inertia of the receptacle. Then it is that the workers building the large cells give the queen a choice between two distinct classes of alveoli; and she, stimulated by the presence of the large alveoli, which seem to possess the power of rendering her reflexes more energetic*, will concentrate from that time all her energies upon them, and will only lay fecundated eggs and females. The modification thus introduced into the theory is important, because it replaces the voluntary act of the queen by a passive one. The queen does not deposit males and females at will; but there comes a time when she cannot do otherwise than deposit males, because of the relative inertia of her receptacle. Among the bees the queen appears to be always conscious † of this state of inertia, and when she is subjected to it she will never lay in any other cell but that of a male, unless there are none of them at her disposal (observations of Drory). It is not the same among the wasps, which mark a less perfect stage in the evolution of the phenomena relating to reproduction. With them the queen lays haphazard when she finds herself over the small cells, and then, according as her receptacle reacts or remains inactive, the deposit (of eggs) gives rise to patches and streaks of workers or to patches and streaks of males, set irregularly and without order one beside the other. If, on the other hand, the queen finds herself over the large cells, stimulated by their presence, she will only lay fecundated and female eggs.

It is very remarkable that, among the wasps, the large cells (queen cells) are adapted to the state of activity of the receptacle, whilst among the bees the large cells (male cells) are adapted to her state of inertia.

Possibly further observations may bring into line other factors not at present suspected, and will modify the theory which has just been laid down. Its only value consists in its giving an acceptable explanation of facts hitherto known and of those which I have just set forth.

Laying of Workers.—This deposit is normal in August in the nests which have their queens; it exists, however, in a relatively small degree, and is not sufficient to account for the great rise in (the number of) males; then it diminishes and ceases completely in normal nests in September and in October. The laying of workers is exaggerated in an extraordinary degree by the simple fact of the suppression of the queen or by her ceasing to lay.

* The queen in captivity shows a marked preference for the large cells.

† The term *conscious* is not altogether correct, but it saves a periphrasis; it is rather a matter of adaptation, of pre-established harmony, than of consciousness.

It can be then provoked in workers in captivity to the extent of obtaining one third fertile, whilst the workers of the same nest in the company of the queen remain sterile. A nest of *Vespa vulgaris*, in which the laying of eggs by the queen had been completely interrupted, yielded more than one half fertile workers, whilst other normal nests, taken at the same time, yielded only sterile workers.

It is evident that in these different cases the fecundity of the workers can only be provoked by the absence of the young brood in the nest and by the upsetting of the equilibrium of nutrition in favour of the adults which results from it.

The production of fertile workers is independent of the bringing up of the queens, contrary to the state of things which, according to Huber, exists among bees. Their fecundity depends upon the nutrition of the imago, and has so much the more chance to develop itself because the worker is hatched after a shorter lapse of time and is nourished in a manner much more intense.

The fecundity of the workers can only establish itself in a nest when the food-collecting section of the community greatly exceeds the larval, or, in other words, when the nutritive condition of the colony reaches its climax, that is to say, in normal nests in the month of August.—*Comptes Rendus*, t. cxxi. pp. 731-734.

Researches on the Structure, Organization, and Classification of the Fossil Reptilia.—Part X. *On the complete Skeleton of an Anomodont Reptile* (*Aristodesmus Rüttimeyeri*, *Wiedersheim*), *from the Bunter Sandstone of Reichen, near Basel, giving new Evidence of the Relation of the Anomodontia to the Monotremata.* By H. G. SEELEY, F.R.S.

With the co-operation of the Trustees of the University Museum of Basel and Professor Rüttimeyer the author has examined the fossil described by Dr. Robert Wiedersheim in 1878 as *Labyrinthodon Rüttimeyeri*. The bones are differently interpreted:—

The reputed humerus is the interclavicle.

The reputed scapula is the humerus.

The reputed supra-scapula is the left coracoid.

The reputed supra-scapula is the right scapula.

The reputed right and left coracoids are the pre-coracoid and coracoid of the right side.

The reputed clavicles are the ribs.

Five digits are identified in place of four in 1878.

These osteological identifications are inconsistent with reference of the type to the Labyrinthodontia. The author also examines the relation of the Labyrinthodont type to existing Amphibia, and regards the Labyrinthodont osteology as demonstrating closer relationship with Ichthyosauria and Anomodontia. The group is therefore regarded as reptilian, forming a branchiate division of the class.